CLAIMS

What is claimed is:

1. A method for performing surface ablation of a cornea to remove corneal tissue, comprising applying a series of laser pulses, each having a substantially radially-symmetric Gaussian intensity profile, said series of laser pulses applied in a pattern to create a corresponding plurality of etch profiles with an substantially radially-symmetrical, Gaussian-like profile, said circular etch profiles applied in a series of etch layers that overlap to substantially reduce ridges and grooves between etch profiles.

2. The method of claim 1 wherein said etch profiles have a substantially super-Gaussian profile.

3. The method of claim 1, further comprising generating a plurality of said laser pulses with an energy density less than or equal to about 10mJ/cm^2.

4. The method of claim 3 further comprising generating said plurality of laser pulses with a duration within a range of about 1-5000 picoseconds.

5. The method of claim 1 further comprising generating said plurality of laser pulses with a wavelength within the range of about 198-300 nanometers.

6. The method of claim 5 further comprising generating said laser pulses in a

frequency-converted solid-state laser.

7. The method of claim 5 further comprising generating said laser pulses in an excimer laser.

8. The method of claim 1 further comprising generating a plurality of said laser pulses with an ablation energy density greater than two times the ablation energy threshold of the cornea.

9. The method of claim 1 further comprising generating a plurality of said laser pulses with an ablation energy density that provides an ablation depth of less than or equal to about 0.2 microns.

10. The method of claim 1 further comprising creating each of the etch layers by applying the pulses so that the etch profiles in each layer do not substantially overlap the other etch profiles in said etch layer.

11. The method of claim 1 wherein etch profiles in each etch layer are substantially contiguous and non-overlapping, thereby defining gaps between adjacent etch circles.

12. The method of claim 1 further comprising applying said etch layers so that at least one subsequent etch layer overlaps a previous etch layer thereby etching at least a part of said ridge created in said previous layer.

13. The method of claim 12, wherein at least a first and a second of said etch layers have a substantially identical pattern, and said second layer is offset from said first layer to provide said overlapping.

14. The method of claim 13, wherein the pattern of the etch profiles in each of at least four of said etch layers has a hexagonally-packed configuration in which the etch profiles are substantially adjacent so that said pattern defines an origin and three approximate intersection points between adjacent circles, further comprising etching a first etch layer at a first origin, and then etching a second layer at a second origin substantially aligned with the first intersection point, then etching the third layer at a third origin substantially aligned with the third intersection point, and then etching the fourth layer at a third origin substantially aligned with the third intersection point.

15. A scanning laser device for ophthalmic surgery of the cornea, the device comprising:

a laser source for generating a plurality of substantially radially-symmetric Gaussian laser pulses, each pulse ablating a corresponding predetermined characteristic profile of corneal tissue to be ablated;

a scanning means for directing each of the laser pulses and depositing the pulses in a predetermined area of the cornea;

a computer device coupled to the scanning means for directing each laser pulse to a location of the cornea; and

a computer device coupled to the scanning means for directing each laser pulse to a location on the cornea, including

a first executable program for controlling the laser source based on input parameters including a predetermined shape of corneal tissue to be ablated, the predetermined shaped ablation tissue profile generated by each laser pulse, and a predetermined pulse deposit pattern,

the first executable program providing output control parameters including a plurality of layers of corneal tissue to be ablated, a plurality of diameters and boundaries of ablation area for each of the layers, and a plurality of laser pulse locations used for each layer, and

a second executable program for directing each of the laser pulses to locations on the cornea in accordance with the output control parameters whereby a predetermined corneal shape is achieved.

16. The device of claim 15, wherein the laser pulses comprise a radially-symmetric super-Gaussian shape.

17. The device of claim 15 wherein the pulse deposit pattern comprises a series of etch layers, each etch layer having laser pulse deposit locations sufficiently far apart from each other so that the tissue ablation profile has substantially no overlap with the tissue ablation profile of the next laser pulse in the etch layer.

18. The device of claim 17 wherein the pulse deposit patterns of said etch layers overlap to substantially reduce groove and ridges.

19. The device of claim 15 wherein the first executable program includes:

means for calculating an ablation depth per layer of the deposit pattern;

means for calculating the number of layers required to ablate the total depth of the predetermined shape of corneal tissue; and

means for determining an area boundary for each layer of the deposit pattern.

20. The device of claim 15 wherein means for directing each of the laser pulses comprises generating a sequential scan such that each of the laser pulses is deposited in an orderly sequence until all locations of the predetermined pulse deposit pattern are scanned.

21. The device of claim 20 wherein the orderly sequence is selected from the group consisting of: a linear scan, a circular scan, and a spiral scan.

22. The device of claim 15 wherein the means for directing each of the laser pulses comprises generating a random scan sequence such that each of the laser pulses is deposited in random until all locations of the predetermined pulse deposit pattern are scanned.

23. A method of corneal tissue ablation using a scanning laser beam device, the method comprising:

selecting a laser source for generating a pulsating laser beam, each laser beam pulse having a predetermined substantially radially-symmetric

Gaussian intensity profile that provides a predetermined approximately circular tissue ablation profile;

selecting a predetermined laser pulse deposit pattern;

determining the shape of the corneal tissue to be ablated;

calculating, based upon the predetermined ablation profile of the laser pulse, a number of layers of the pulse deposit pattern, a diameter and a boundary of each of the layers, and a number of laser pulses required to ablate the entire shape of the corneal tissue; and

directing the laser beam to locations of the pulse deposit pattern with the scanning laser beam device until substantially all locations within the boundary of all layers are scanned, such that a desired shape of the corneal tissue is ablated.

24. The method of claim 23, wherein the intensity profile of the laser pulse comprises a super-Gaussian shape.

25. The method of claim 23, wherein the pulse deposit pattern comprises a series of etch layers, each etch layer having laser pulse deposit locations sufficiently far apart from each other so that the tissue ablation profile has substantially no overlap with the tissue ablation profile of the next laser pulse in the etch layer.

26. The method of claim 25, wherein the pulse deposit patterns of said etch layers overlap to substantially reduce groove and ridges.

27. The method of claim 23, wherein said calculating step further comprises:

calculating an ablation depth per layer of the deposit pattern;

calculating the number of layers required to ablate total depth of the predetermined shape of corneal tissue; and

determining an area boundary for each layer of the deposit pattern.

28. The method of claim 23, further wherein the step of directing each of the laser pulses further comprises generating a sequential scan such that each of the laser pulses is deposited in an orderly sequence until all locations of the predetermined pulse deposit pattern are scanned.

29. The method of claim 23, wherein the orderly sequence is selected from the group consisting of: a linear scan, a circular scan, and a spiral scan.

30. The method of claim 23, wherein the step of directing each of the laser pulses comprises generating a random scan sequence such that each of the laser pulses is deposited in random until substantially all locations of the predetermined pulse deposit pattern are scanned.